

ABSTRACT

SCIENCE-BASED RESTORATION MONITORING OF COASTAL HABITATS: A FRAMEWORK AND TOOLS FOR MONITORING PLANS UNDER THE ESTUARIES AND CLEAN WATER ACT OF 2000

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INTRODUCTION

The Estuary Restoration Act of 2000 (ERA), Title I of the Estuaries and Clean Water Act of 2000, was created to promote the restoration of habitats along the coast of the United States and its protectorates. The NOAA National Centers for Coastal Ocean Science were charged with the development of a guidance manual for monitoring plans under the Estuaries and Clean Water Act of 2000.

The manual provides technical assistance, outlines necessary steps, and provides useful tools for the development and implementation of sound scientific monitoring of coastal restoration efforts. By definition, *coastal* in this Act includes marine coastal and coastal areas of the Great Lakes. In addition, the manual offers a means to detect early warnings that the restoration is not on track; to gauge how well a restoration site is functioning; to evaluate the ecological health of a coastal habitat both before and after project completion; and to coordinate projects and efforts for consistent and successful restoration (Galatowitsch et al. 1998).

The manual is written for those involved in developing and implementing restoration monitoring plans including restoration professionals in academia, private industry, Federal, state, local, tribal governments, volunteer groups, non-governmental organizations, and environmental advocates.

The manual was written in two volumes which are currently under review. The first volume contains a background on restoration and monitoring, stages of a restoration and monitoring plans; how to create a monitoring plan; and important information that should be considered when monitoring specific habitats. The second volume provides detailed information of the habitats, an inventory of coastal restoration monitoring program, a review of monitoring techniques manuals and quality control/quality assurance documents, an overview of governmental acts affiliated with monitoring, cost analysis of monitoring expenses, a glossary of terms, and a discussion of socioeconomic issues affiliated with coastal habitat restoration. The following habitats have been selected for discussion in this manual: water column, coral reefs, oyster reefs, soft bottom, kelp and large macroalgae, rocky shoreline, soft shoreline, submerged aquatic vegetation including seagrasses, brackish and freshwater submergents, marine and brackish

marshes, freshwater marshes, mangrove swamps, deepwater swamps, and bottomland forests.

This manual is not intended to be a restoration monitoring Acookbook® that provides templates of monitoring plans for specific habitats. The interdependence of a large number of site-specific factors causes habitat types to vary in physical and biological structure within and between regions and geographic locations (Kusler and Kentula 1990). Monitoring techniques used must be tailored to these differences. Even with the diversity of habitats that may need to be restored and the extreme geographic range across which these habitats occur, there are consistent principles and approaches that form a common basis for effective monitoring. We believe that this manual will provide guidance for users to select appropriate sampling protocols, sampling designs, statistical protocols, and sampling techniques. We have not specified the techniques and protocols to use, only provided guidance, because these can only be selected by gaining an understanding of the local conditions. Additionally, there are a variety of available techniques for most metrics or characteristics recommended for evaluation, and it would be presumptive for us to recommend a single technique for a specific characteristic when the appropriate technique should be selected by the panel developing the restoration and monitoring plan.

HIGHLIGHTS FROM VOLUME I

Some of the most informative information presented in the first volume of this guidance manual is highlighted here. Topics highlighted included the stages for restoration and monitoring, the developmental process for monitoring plans, and how to write a monitoring plan.

STAGES FOR RESTORATION AND MONITORING

Monitoring facilitates the success of restoration projects in a variety of ways. Restoration monitoring is a means to detect problems early that the restoration project might not be on track to achieve its goals. It can be used to gauge how well a restoration site is functioning, to evaluate the ecological health of a coastal habitat both before and after project implementation, and to compare information for consistent and successful future restorations (Galatowitsch et al. 1998). Restoration projects are divided into four phases.

Phase I: Project Conception and Design – Before construction commences, project goals and objectives are established and clearly defined. It is also necessary at this stage to establish monitoring criteria to determine how progress toward these goals and objectives will be measured.

Phase II: Monitoring Plan Development and Data Collection – Prior to construction, comprehensive surveys of reference sites and the area to be restored should be conducted to establish baseline environmental data. Information can be obtained through analyses of archival materials and historical databases. Field sampling and surveys must be done to address gaps in knowledge and to check the veracity of archival information. Modeling may be necessary, depending on the project in question. Once baseline data has been collected, the monitoring plan can be finalized. When developing the monitoring plan, several characteristics must be considered such as habitat characteristics, timing of sampling, structural characteristics, and functional characteristics. Reference sites against which the project area will be compared need to be identified along with testable hypotheses for each restoration goal. Valid statistical

sampling and analyses must be established for each habitat characteristic to be monitored. Data should be reported in a format compatible with the NOAA ERA database.

Phase III: Data Collection During Construction – Upon completion of baseline data collection and monitoring plan development, restoration construction can commence according to project design and specifications. Monitoring should be implemented during construction to insure that proper design specifications are met.

Phase IV: Post-Construction Monitoring – Post-construction monitoring should be done following the monitoring plan, including the collection and analysis of data in a statistically valid manner. Data should be made available to project managers and engineers in a timely manner, as per the monitoring plan, to allow for adaptive management of the restoration project and associated programs.

DEVELOPMENTAL PROCESS FOR MONITORING PLANS

The process for development of a scientifically based and statistically valid monitoring plan should address the following points:

- Determining the project goals and any applicable watershed restoration plan goals
- Identify project type and collect information on monitoring of similar projects
- Identify and describe the extent of the habitats within the project area
- Define basic structural and functional characteristics for the habitat types
- Consult experts throughout the monitoring process
- Collect historical data and indications of trends and causes of decline
- Identify reference sites
- Identify monitoring time span and techniques to be used
- Design a monitoring review and revision process that complies with the requirements of the restoration program
- Develop a cost estimate for implementation of the monitoring plan and compare to available funds

WRITING A MONITORING PLAN

A monitoring plan should contain certain basic information that allows managers, scientists, and statisticians participating in the monitoring of the project to understand what is to be done, when it is to be done, and why it was included in the plan. The five critical plan elements include:

Background Materials including a description of the project area, habitat types, acreage, a discussion of the habitat trends and causes of loss or decline in the area, and a review of the project, including all components and timetables.

Project Goals and Objectives of the regional restoration plan relevant to monitoring.

Monitoring Components

- List of habitat characteristics or functions to be monitored
- Statement of the null and alternative hypotheses to be tested as a means of assessing progress toward project and regional restoration goal

- Discussion of the reference sites to be used, including location and the methods used in and justification for selection of the sites
- Detail of pre-construction sampling to be used to establish historical and baseline conditions, including techniques, frequency, and sampling QA/QC
- Detailed plan for sampling during and after construction, including techniques, frequency, sampling QA/QC, and provisions for adaptive management.
- Discussion of statistical analysis to be employed in the testing of the null hypotheses
- Detailed plan for data handling, storage, and accessibility (data QA/QC procedures)
- Report preparation and distribution plan
- Provision for the review of the effectiveness and efficiency of the monitoring plan after implementation

Projected Monitoring Budget estimates of the costs associated with the implementation of the monitoring provided by category of cost and by year

Participants and Contact Information for the restoration project manager and monitoring plan manager and a list of all individuals involved in the development and review of the plan.

HIGHLIGHTS FROM VOLUME II

Volume II gives detailed descriptions and restoration concerns of each habitat chosen for discussion in this manual. In addition, for each habitat an annotated bibliography and summaries of monitoring restoration projects is presented. The authors received input from experts in each habitat type and have provided a series of structural and functional characteristics recommended for evaluation of the trajectory of development of the restoration and success of the action. Additionally, a number of these characteristics have been identified as very important to consider in development of the restoration plan.

Volume II also provides restoration practitioners with several other useful tools. One tool is a review of restoration monitoring programs in the United States. Another tool are annotated bibliographies and reviews of restoration monitoring programs allow practitioners to determine what specific techniques have been or are being used in similar habitats and to guide them to additional information as needed. Also, in Volume II readers will find a review of acts relevant to restoration monitoring. There is a sample list of costs associated with restoration monitoring allows project managers to make preliminary budget estimates. Socioeconomic monitoring factors, analogous to biological monitoring factors, associated with restoration have been identified that can be used to track and characterize the economic and social effects of restoration projects. And finally, a glossary of terms is included.

LITERATURE CITED

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